Space Weather Forecast

Issued on Friday, 15 December 2023 at 13:18 Local

This forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: High activity with further Moderate flares likely, and chance of Strong flares (R1-R3). G1 Minor Storms possible from Coronal Mass ejection (CME) arrivals Days 1-2 (16-17 Dec). Initial assessment of Strong flare CME gives a chance of G1-G2 early Day 3 (17 Dec).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with a strong flare from the complex sunspot in the northwest disc, peaking 14/1702 UTC. This was the largest flare of the current solar cycle so far, and the largest since Sep 2017. Three further Moderate flares were also observed from this same region. This is a complex and moderately sized region approaching the northwest limb, which saw ongoing growth and development through the last 48 hours. Since the Strong flare and subsequent Moderate flares, development of the region has continued and further flares are possible. This is one of eight other active regions on the disc, however the other regions are largely smaller and simpler, with no significant growth observed.

Three CMEs were observed in the last 24 hours with potential Earth-directed components. The first was due to an eruption across the northern hemisphere, starting 14/1109 UTC, and the second was from the Strong flare. These have been assessed, with the Strong flare CME likely sweeping up the weaker eruption, with an arrival time estimated as early Day 3 (17 Dec). The Moderate flare from earlier 15 Dec from the same region also produced a CME, with analysis awaiting. Any other CMEs in the last 24 hours have been assessed as not having earth-directed components.

Solar Wind / Geomagnetic Activity: Solar winds were initially indicative of the tail end of a passing weak coronal mass ejection (CME), which had arrived late on 13 Dec. Speeds persisted at background, near 350 km/s, before a sudden shock was observed at 15/1057 UTC, indicative of the arrival of a possible CME. Wind speeds increased to around 400 km/s. The interplanetary magnetic field (IMF) was initially Weak, increasing to Moderate-Strong after the CME arrival. The north-south component was generally negative (southward) and Weak, before increasing to Moderate after the CME arrival. Geomagnetic activity was initially Unsettled (Kp3), but eased to be Quiet from 14/1500 UTC (Kp1-2).

Energetic Particles / Solar Radiation: The count rate of energetic particles (high energy protons) rose slightly above background after the strong flare, but remained well below the S1 Minor Radiation Storm Level.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity expected with the ongoing likelihood of Moderate class (R1-R2) flares and a chance of further isolated Strong class (R3) flares from the complex sunspot region in the northwest. This risk recedes later Day 3 and through Day 4 (17-18 Dec) as the region moves further around the far-side.

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Solar Wind / Geomagnetic Activity: There are two Earth-directed coronal mass ejections (CME) arrivals expected. The first from the 13 Dec eruption near the complex sunspot region in the northwest, early on Day 2 (16 Dec), and the second from the Strong flare on 14 Dec from the same region, early on Day 3 (17 Dec)

The observed CME arrival early on Day 1 (15 Dec) may be the first forecast CME arriving early, but perhaps more likely is as a result of an un-forecast CME. As such, this CME is kept in the forecast to arrive early on Day 2, but with slightly lower confidence. The second CME has had an initial assessment, with an arrival time estimated for early Day 3 (17 Dec). Otherwise a coronal hole high speed stream may bring a weak enhancement on Day 1 (15 Dec), with a second coronal hole having the potential to enhance winds on Day 4 (18 Dec), although this is very low confidence.

Overall, geomagnetic activity is forecast to be Quiet to Unsettled at first, rising to Active and possibly to G1/Minor Storm levels, under the influence of the recent CME arrival, as well as any weak coronal hole enhancements on Day 1 (15 Dec). The CME arrival early on Day 2 (16 Dec) brings a chance of a spell of Active to G1/Minor Storm intervals. The CME arrival on Day 3 (17 Dec) is less certain, but could bring G1-G2 Minor to Moderate storms. Another coronal hole fast wind may arrive on Day 4 (18 Dec), with Unsettled to Active intervals possible.

Energetic Particles / Solar Radiation: The count rate of energetic particles (high energy protons) is expected to continue rising for a time Day 1, with a slight chance of reaching the S1 Minor Storm levels. Any further significant flares from the complex sunspot will increase this risk, leading to an ongoing chance of reaching this level through the period.

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Met Office Space Weather Forecast

Geomagnetic Storms:

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	40	40	10
Strong	G3	No	1	15	15	1
Severe	G4	No	1	2	2	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X Ray Flares:

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	70	70	60	50
Very Active	R3 to R5 X	Yes	30	30	20	5

Solar Radiation Storms - (High Energy Protons):

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	30	25	25	20
Very Active	≥ S3 *	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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